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RECENT WORK ON THE INHERITANCE OF ACQUIRED CHARACTERS.

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It has long been known that a change in the environment may produce a definite effect on the structure of many animals, and until Weissman pointed out the theoretical objections to the possibility of such effects being inherited, it had been thought unnecessary to actually prove that this took place.

Since this difficulty has been generally admitted, the onus of proof rests with those who believe in the inheritance of acquired characters, and it must be admitted that nothing sufficiently satisfactory in the way of evidence has been adduced to shake the disbelief in such inheritance.

Certain recent work, nevertheless, suggests that, however great may be the theoretical improbability of the inheritance of acquired characters, the results of experiment cannot be interpreted on any other supposition.

The work of Tower on *Leptinotarsa*, the Colorado potato-beetle, has recently been brought prominently before the zoological world by Professor Bourne in his Presidential Address to Section D of the British Association at Sheffield. As this Address appeared in 'The Zoologist' (*ante*, p. 347), it will not be necessary to describe Tower's results in detail. He found that he could produce melanic varieties of the beetles by subjecting them to a slight increase or decrease of temperature during the

pupal stage. Albinic varieties were produced by subjecting the pupæ to a more considerable increase or decrease of temperature. Such changes were not inherited. But if the altered temperature was maintained during the adult stage some of the offspring were found to be similar to their parents. This effect was traced to the action of the environment on the germ-cells themselves during their maturation. For, if normal beetles were placed in changed conditions during the maturation of some of their eggs, and put back into normal conditions during the maturation of others, the adults arising from the first batch of eggs showed aberrations, whilst those from the second did not. The aberrations produced by the action of the changed environment on the maturing germ-cells were inherited completely—that is to say, individuals exhibiting such variations bred true in normal conditions, and when crossed with the parent form a typical Mendelian segregation occurred in the second generation, in each case the original form acting as a dominant to the variety. Now, if these beetles had been kept constantly in a changed environment, it would have appeared that the aberrations induced in the first generation by the environment had been inherited in the next generation; whereas, in reality, in the first generation the variation is merely a fluctuation, in the second it is of the nature of a mutation. When once the germ-plasm has been changed, it is natural that every individual resulting from that germ-plasm should show the same change, and this is exactly what Tower found.

We cannot, therefore, claim that these experiments support the inheritance of acquired characters, as at first sight they appear to do. On the contrary, acquired characters (*i. e.* characters produced in the somatic cells) are never inherited. For the changes to be inherited, it is necessary to directly influence the germ-cells.

The experiments of Standfuss on *Vanessa urticae*, which were confirmed by Weissman, and those of Fischer on *Arctia caja*, yielded results which must be briefly considered. Fischer, for instance, found that by exposing the pupæ to a temperature of 8° C. a certain number of dark aberrant moths resulted. When a pair of these were mated and their eggs reared under normal conditions a certain number of the offspring were dark, but not



so dark as their parents. Standfuss and Weissman found that *Vanessa urticae* behaved in a similar way.

It is possible to bring these results into line with those of Tower, if we assume that in Lepidoptera the germ-plasm can be influenced even in the pupal stage, but the action on the germ-cell in this case does not influence the colour of the adult so much as the action on the pupa. We cannot, therefore, claim these investigations as a proof of the inheritance of acquired characters.

It is quite different, however, with the work of P. Kammerer on Salamanders and on Alytes, the results of which have been published in the 'Archiv. fur Entwicklungs-Mechanik,' Bd. xvii. (1904), Bd. xxv. (1907), and Bd. xxviii. (1909). I propose, therefore, to give a longer account of Kammerer's work, especially as, so far as I am aware, no such account has appeared in English up to the present time.

Two species of Salamander occur in Central Europe. The ordinary lowland Salamander is the Spotted Salamander (*S. maculosa*), whilst in mountainous regions it is replaced by the Black Salamander (*S. atra*).

The Spotted Salamander is black, with irregular large yellow markings on the back and limbs. This combination of yellow and black is a typical warning coloration, and indicates that the animal is poisonous. The female carries the eggs in her uterus for ten months, and in May enters the water, generally at night, and gives birth to from a few to fifty young, fifteen being about the average number. The young are surrounded by the egg-membrane, which either bursts before or shortly after expulsion. The new-born Salamanders have three pairs of long external gills, a long tail furnished with a broad dorsal and ventral fin, and four limbs, although these are small. The total length is about 25 mm. or 1 in. Their general colour is blackish, with a metallic golden and greenish lustre. They are very active, and at once eat dead or living animal matter. During the first six or eight weeks they assume a row of dark spots on the sides; these spots enlarge, and the whole skin becomes darker. Yellow spots appear next, first above the eyes and on the thighs, later upon the back; the ground colour at the same time becomes black. The metamorphosis is very gradual; the tail-fin

diminishes first, but the gills grow until shortly before the little creatures leave the water.

The Black Salamander differs from the Spotted Salamander in its uniform black colour and smaller size. It is restricted to the Alps at from 2000 ft. to as much as 9000 ft. elevation, living near waterfalls, or in other damp and cool situations. The most interesting feature of the species is that it produces only two young at a time. These are nourished at the expense of the partly developed eggs in the uterus, and they undergo their whole metamorphosis before they are born. Their development is divided by Schwalbe into three stages:—

(1) Still enclosed within its own follicle the embryo lives on its own yolk.

(2) Free within the vitelline mass, which is the product of the other eggs, the larva feeds by taking this in at the mouth.

(3) After the vitelline mass is absorbed, the embryo obtains its nutriment from the wall of the uterus by means of gills 10 to 12 mm. in length.

These two species of *Salamandra* are thus at once distinguished by their colour, habitat, and reproductive habits. Yet even in Nature they approach one another more than has been indicated so far. For the abortive eggs in the uterus increase in number in *S. maculosa* with increasing elevation of the habitat, the embryos decreasing in number and attaining a later stage of development before birth. The same process can take place in situations other than mountain districts if the conditions are unfavourable.

At the lower limit of *S. atra* an increase in the number of embryos may occur, three or four being produced at a birth, whilst the abortive embryos do not break up so early to form the vitelline mass. In the lower habitats of *S. atra* examples with small whitish spots are not infrequent. The yellow spots of *S. maculosa* are most complete in regard to number, size, and brightness of colouring in warm, moist localities on a clay soil, and diminish in size, number, and brilliance with increasing elevation of the habitat. These facts suggested to Kammerer the attempt to convert one species into the other, an attempt which has been to some extent successful.

If the embryos of *Salamandra atra* are liberated from the

uterus and placed in water, they cast off their richly vascular long red gills and regenerate in their place stouter branched gills like those of the larvæ of *S. maculosa*. Moreover, if females of *S. atra* are collected from the lower habitats and kept in warm conditions they often naturally deposit their young in the water in the larval stage, and these young are usually more than two in number. On the other hand, females of *S. maculosa*, which are deprived of the opportunity of depositing their young in the water, detain them to their final metamorphosis in the uterus. The nourishment in this case is exactly similar to that which normally takes place in *S. atra*, only a few embryos surviving, the rest breaking down to form a vitelline mass. These intra-uterine embryos differ from the normal free-swimming larvæ at the same age in their possession of long vascular gills. Their tail-fins are very small, and they retain their primary dark colour.

After metamorphosis these animals are still distinguished from normal *S. maculosa* of the same age by their smaller size and the lesser number of the yellow spots on the black background. Young *S. maculosa*, however reared, if kept on black earth at a low temperature and with little moisture, exhibit a preponderance of the black ground colour at the expense of the yellow spots. On the other hand, if young *S. atra* are kept on a clayey soil at a relatively high temperature and in a nearly saturated atmosphere, small whitish points appear on the skin, which sometimes expand into small yellow spots.

Salamandra maculosa can also be modified in the opposite direction, and become truly oviparous. This occurs if the female is stroked, or if she is kept in a completely saturated atmosphere, or if she is placed suddenly in ice-cold water. If the same individual is treated in this manner for several spawning periods, she eventually acquires the habit of laying her eggs early, even if the stimulus is not applied. From eggs obtained in this way the larvæ do not emerge for about a fortnight, and when hatched only possess the anterior pair of limbs, though the posterior appear the following day.

Under the same influences *Salamandra atra* can be got to produce her larvæ in the water in the larval stage, and then gives birth to from three to nine at a time instead of two. If

the stimuli are applied for several spawning periods in succession this method of reproduction becomes habitual in the individual, and occurs without further stimulation. The larvæ thus produced are coffee-brown or grey (instead of black), striped with darker bands. Their movements are much more intelligent than those of larvæ at the same stage which have been cut out of the uterus by an operation, and the gills become adapted for aquatic respiration much more rapidly. Moreover, they at once begin to feed on small aquatic animals. These larvæ, when they reach the sexually mature stage, in their turn produce aquatic larval forms even in the first spawning period, and it is found that the stimuli necessary to produce this result need not be so large in amount as was the case in their parents.

Exactly similar results are obtained with the young produced in the adult stage by *S. maculosa*. At the first spawning period they only produce one young Salamander in each uterus in the method normal for *S. atra*—that is, if the original experimental conditions are continued. Even if these conditions are not continued, they show the influence of their origin, though to a less extent. For they either produce relatively advanced larvæ in the water, which possess long uterine gills and metamorphose after a few days, or they produce larvæ on the land which have rudimentary gills, and are incapable of living in deep water. These land larvæ in a few days metamorphose to adult Salamanders, which from their small size and uniform black pigment might readily be taken for the young of *S. atra*. It thus appears that in every case an inheritance of the acquired developmental characters has taken place.

In a more recent paper Kammerer has published the results of a similar series of experiments on *Alytes obstetricans*, the Midwife Toad. The habits of this species in the wild state are quite unusual. It propagates itself on land, and lays from eighteen to eighty-six heavily-yolked eggs in a long chain; this chain is drawn out from the cloaca of the female by the male during the act of copulation, and at the same time he wraps them round his thighs. The gelatinous envelope of the eggs is very sticky, and attaches them to his legs, and by subsequent shrinking the band is drawn tight. While the male is in charge of the eggs he forsakes his usual habits, and diligently seeks for water in which

he can at intervals dip his legs, and if the eggs are kept wet enough the embryos eventually emerge into the water, biting their way out of the egg-shells by their horny beaks. Their post-embryonic development lasts more than a year.

Now, if *Alytes* is kept at a temperature of from 25° to 30° C., the male draws the eggs out of the cloaca of the female, but does not wind them round his legs. If this happens on land the adhesion is prevented by the rapid drying up of the jelly, but it more often happens in the water, since the heat causes the Toads to forsake their usual habits and cool themselves in the water, and here the adhesion is prevented by the rapid swelling of the jelly. The movements of the embryo inside the egg are sufficient to effect the disruption of the membrane, which is macerated by this swelling in the water, and the embryos escape after two weeks at a very early stage with a yolk-sac still attached to them, and long delicate, vascular embryonic gills. These gills are soon replaced by others adapted for respiration in the water. The post-embryonic development only lasts three to four months, and the resulting Toads are exceptionally large.

After a time the adults become accustomed to copulating in the water, and seek it for the purpose even when kept in normal conditions. They then produce from ninety to one hundred and fifteen small eggs with little yolk. This is soon absorbed, and the embryos, impelled by hunger, jerk violently about till they break out of the egg. Since they are not encumbered by a yolk-sac, as were those of earlier broods, they can swim freely at once, and to this end their tail-fins are distinctly broader than in the tadpoles derived from earlier broods. The gills also become more readily adapted to aquatic respiration. The Toads derived from the earlier broods reared in the water lay their eggs on land in the normal fashion if the experimental conditions are relaxed. Those derived from the later broods, however, after spawning in the water has become habitual, show that they inherit this tendency by always spawning there, even without continuance of the conditions.

If the high temperature is still maintained, the eggs produced by this second generation are still smaller and more numerous than in those of the first, and if the process is still continued the larvæ in the fourth generation are darkly pigmented instead of

colourless, have a broad tail-fin, and have three pairs of gills instead of one, these being already adapted for aquatic respiration when the larva hatches.

Sexually mature males in the third generation have rough callosities on the ball of the thumb, and in the fourth generation these are coloured black. In addition these males have hypertrophy of the muscles of the fore-arm. These two effects are evidently correlated with the extra difficulty experienced by the male in holding the female during the copulatory process, owing to her skin being wet and slippery in the water.

To return to the eggs laid on land and abandoned by the male. If they are kept on damp, cool soil they develop normally, but if the temperature is kept high they develop more rapidly, and if they are prevented from hatching at the proper time by only giving them the minimum amount of moisture very large eggs are obtained, in which the embryos remain for six or seven weeks, and when hatched are already 20 mm. long. If they are also kept in a feeble light giant eggs are formed in which the embryos remain for ten weeks, reaching a length of 31 mm., and possessing the hind pair of legs. The remaining process of development only takes about five months, and the adults produced are distinguished by their dwarf size. These dwarf Toads only produce sixteen to nineteen eggs, from which, if the experimental conditions are discontinued, larvæ emerge after about seven weeks. They are 21 mm. in length, and have undifferentiated stumps as rudiments of the hind limbs. If the experimental conditions are continued, the larvæ hatch out at an even more advanced stage than in the previous generation.

Larvæ from the original land-eggs, or from those in which the embryos have been retained for an extra long period, can live several weeks on damp earth instead of in the water. Their integument becomes thickened, and they develop epidermal glands and lungs; also the tail-fin diminishes, and the muscles of the limbs strengthened. They have to be placed in the water to undergo the metamorphosis, but this takes place in a very short time, the resulting adults being very much dwarfed. If the conditions are relaxed in the next generation, these induced modifications are almost lost, though the lungs are better developed than usual, and metamorphosis occurs earlier. If the

conditions are maintained, a further increase occurs in all the adaptive characters, and the larvæ can live even longer on land.

By prematurely opening the eggs laid in the water, and keeping the embryos in a poor light in a large quantity of cold water with a small food-supply, an *Alytes* larva was produced which remained for four years and eight months in the larval state, and produced eighteen eggs, which were artificially fertilized with the sperm of a normal male. The larvæ reared from these eggs under normal conditions were distinguished by the long persistence of the external gills, and after two and three-quarter years showed no signs of preparation for the metamorphosis.

Toads kept at a temperature below 17° C. take two years to become sexually mature. If kept above 25° C., this occurs in one year. Offspring of the latter in normal conditions became mature in a year and a half.

Now these results cannot be explained by a direct action of the environment on the germ-cells; for in most cases very little if any effect seems to be produced in the offspring so long as it is necessary to keep the parents in abnormal conditions to get them to change their spawning habits. As soon, however, as the changed habits have been acquired by the parents—that is to say, as soon as the parents can be replaced in normal conditions—then inheritance of these changed habits appears to occur.

We know that in such animals as change colour to adapt themselves to their environment the change is brought about, not directly by the action of the altered environment on the chromatophores of the skin, but indirectly by way of the nervous system. It is often supposed that the action may once have been a direct one, but that the perfection of the nervous system has led to its interposition in the process. Of course, the nervous system is not so directly connected with the germ-plasm as it is with the pigment-cells in the skin, but is it not possible that changes in the nervous system may affect the germ-cells? And there can be no doubt that a change in the characteristic habits of an animal is in some way correlated with a change in its nervous system.

In this connection it is interesting to notice that the chief

series of experiments on the inheritance of mutilations and diseases were those of Brown-Séguard on Guinea-pigs. His experiments consisted in performing various operations on the nervous systems of these animals, and noting the effects produced. He found that in a number of cases such effects were inherited by some of the descendants of the diseased animals.

Brown-Séguard's work is now discredited, since subsequent workers have failed to confirm his results, though it is probable that no one else has during thirty years reared so many thousand Guinea-pigs as he did.

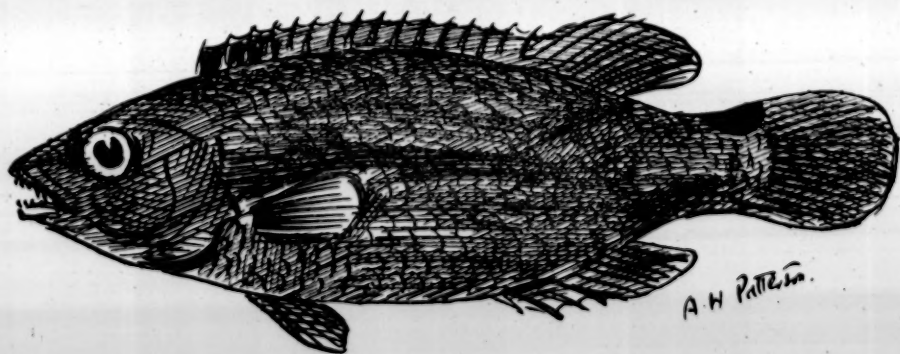
Until someone else has repeated Kammerer's work it is probable that such remarkable results will be regarded with some suspicion by orthodox zoologists, but the experiments are described so fully and accompanied by such clear figures that they ought surely to make us pause before absolutely denying the possibility of the inheritance of acquired characters.

SOME FISH-NOTES FROM GREAT YARMOUTH FOR 1910.

BY ARTHUR H. PATTERSON.

THE year 1910 provided me with no extraordinary ichthyological novelties, the only two items of more than ordinary interest being the discovery of a species of Bonito, which, so far as I can ascertain, has not before been recorded for the East Coast; certainly it is quite new to my own locality. The occurrence of the Velvet Crab is also worthy of note, as having made its appearance in local waters, and for the first time has found its name on the Norfolk list of species. These will be noted in chronological order.

On January 13th Mr. F. C. Cook, of Lowestoft, brought me two examples of Jago's Goldsinny (*Ctenolabrus rupestris*), which he had obtained on the previous day from one of the shrimp-



JAGO'S GOLDSINNY.

trawlers fishing just outside that port. This fish, since my discovery of it off Yarmouth in June, 1906, has not infrequently been taken in shrimp-nets. I am inclined to regard it, at present, as one of the most numerous of the *Labridæ* visiting Norfolk waters. A third specimen from a shrimp-net on August 9th.

A plentiful inshoring of Sand Dabs (*Pleuronectes limanda*)

occurred in March. On the 21st the shrimpers netted hundreds, one man on the 22nd having a "maund" (a fish-basket) full of them. They were in size little longer than a man's hand.

Ballan Wrasse (*Labrus maculatus*): A small example taken on April 11th.

On April 21st I saw a Smeared Dab (*P. microcephalus*), about 10½ in. in length, with the fins surrounding it perfectly white, including the tail. The shopman obliged me by turning over some others on the slab, and we discovered two more almost identical in the peculiarities which characterised the first. I have no doubt they were varieties from the same brood, all being of exactly the same dimensions, and taken simultaneously. I have noticed this tendency to similarity in other instances, one curious "sport" having been accompanied by undoubted relatives.

A Ruffe (*Acerina vulgaris*), drawn down-river on an ebb-tide, was taken alive on Breydon on May 5th.

Obtained a double Flounder (coloured on both sides) on May 20th.

The Lamprey (*Petromyzon marinus*), I have no doubt, is an annual visitant to our Norfolk and Suffolk rivers, ascending for the purpose of spawning. It does not often come under notice, although on rare occasions some numbers have been recorded. On May 23rd a fine female was taken in a small trawl-net at the entrance of Breydon. I cooked this fish, but found the flesh dry and very beef-like in texture, and of a flavour that might have been a combination of Salmon and Skate. The eggs, which were imbedded in a blue-coloured tissue, were small and exceedingly numerous. Another was taken on the 24th, and two others subsequently. Great local prejudice exists with regard to the use of this fish as food.

Day ('British Fishes') speaks of two varieties of the Cod—the dark sort, taken off the Dogger, and the yellower kind, met with off the north of Scotland. I saw, in May, an almost black example with a light lateral line; the head and body seemed more slenderly built than in the typical Cod. I am much inclined to regard this fish as a hybrid between the Cod and Cole-fish, but it was too large an example to purchase for purposes of further investigation.

A fifteen-inch *Scomber concolor*—a whole blue-backed Mackerel without stripings—brought in on May 28th. Two or three Scribbled Mackerel (*S. scomber* var. *scriptus*) were met with during the progress of the fishing.

On June 8th a small schoolboy interested in Sticklebacks, as are most urchins, brought to me a large pickle-bottle in which were a number of very tiny Three-spined Sticklebacks. The boy had found the nest and carefully placed it in the bottle, judiciously adding some vegetable matter from the ditch, while the water was beautifully clean, although for some time unchanged. We could discern minute fish not more than a quarter of an inch in length happily swimming about in their small prison birthplace.

I had shown to me on June 9th a very fine example of *Sebastes norvegicus*. It weighed when full $17\frac{1}{2}$ lb., and when empty 14 lb. It was taken in the trawl, but no definite locality was obtainable.

An Eel was observed in trouble in a ditch at Belton, a few miles south of Yarmouth. A gardener, who saw it making queer antics in an evident endeavour to rid itself of something, shot it, when he discovered the body of a Water-Vole fast in the fish's gullet.

Breydon was alive with "whitebait" (Herring-fry) on the morning of July 30th. I was much interested for some time in watching a Heron standing beside a drain most industriously and adroitly snapping up these lively little fishes.

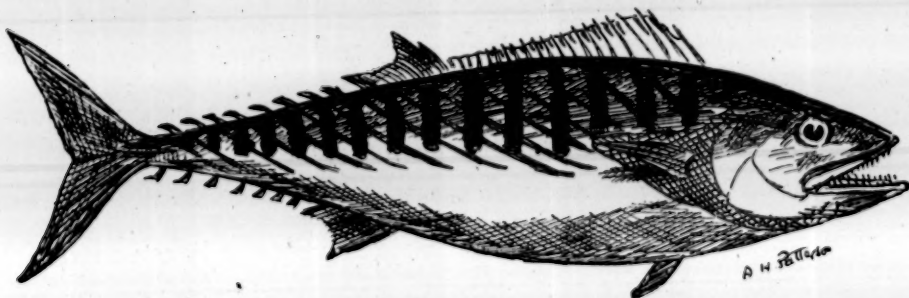
A very pretty example of a variegated Brill, 14 in. in length, came under my notice. The ground-work of the upper surface was white, but the tail and round the eyes exhibited the normal colouring, and nine spots were regularly dotted around the fish, four on each side, and one on the lateral line an inch or two off the tail. These spots were about the size of a florin.

An incursion of small Pollack (*Gadus pollachius*) noticeable during the third week in September; they were about the size of an average Mackerel.

September 24th: Saw a fine Porbeagle Shark (*Lamna cornubica*) on the fish-wharf, just landed from a fishing-boat. Length, nine feet.

Flounders coloured on both sides are by no means rare—all-white Flounders are rare. One was shown me on October 6th, seven inches in length; there was only a faint narrow brown ring around each eye. The upper surface was entirely devoid of spiny excrescences, and as smooth as porcelain.

My best find for the year was *Pelamys sarda*. When strolling to the harbour-mouth on the afternoon of October 30th—a wild dreary day, with a keen wind from the north-east, and with a great quantity of wreckage strewn along the shore—I noticed among other half-putrid fishes a Mackerel-like specimen from whose sides all the skin, save a little near the back, had been abraded by sea-water and the surf that had tumbled it to the tide-mark. I noticed at once its greater girth around the middle, and suspected it to be a Bonito of some sort, which



PELAMYS SARDA.

impression was strengthened by the rows of pronounced teeth, which were much larger and more conspicuous than in the Mackerel. I regretted having left my knife at home; and also the want of some newspaper to wrap it in. Roughly measuring it at seventeen inches, I left it. My rest at night was much disturbed by my disappointment at leaving it behind, and I was up before daylight on the following morning, when I hurriedly trudged to the harbour-mouth, where I was fortunate in re-discovering it just before the tide had reached it. The Hooded Crows had already been at it, apparently intending to finish the disembowelling they had begun on the previous day. I whipped out a table-knife with which I had armed myself, and was soon on my homeward journey with the head in my pocket. On reaching home I washed and put it into formalin, despatching it at night to Dr. Boulenger, who very kindly at once confirmed

my identification, assuring me it was the Pelamid, which is known also as the Belted Bonito, or the Short-finned Tunny. So far as I can trace, it is new to the East Anglian coast.

It is more than probable that Day's illustration ('British Fishes,' vol. i. pl. 38) is, so far as markings go, a correct representation of the species. It is, however, to my mind, a trifle too slender when compared with my example, as is Couch's figure, the markings of which do not correspond with Day's drawing. Yarrell's drawings of the Bonitos are to me confused and unsatisfactory. I regret the condition of my specimen, which, although so knocked about, could not have been dead more than three or four days. The Hooded Crows that had forestalled me in the discovery had already started disembowelling it, evidently deciding that it was not too far gone for their liking.

Elated by my "find" of October 30th, I was tempted to renew my visit to the harbour-mouth on November 12th, when, to my great surprise, lying among a few starfishes, weeds, and crabs drawn up at the tide-mark, I observed a large Mackerel-like head with pronounced teeth, and immediately recognized it as that of *Pelamys sarda*. In this case the body had been either cut or broken off, probably the latter, and it was in such a condition of decay as to warrant my belief that it had been netted a very short time after, or more likely contemporary with, my first example. The eye-sockets contained only the eye-casings, and the smell was rancid, my fingers retaining this pungent odour after a good washing. My opinion is that a small party of these Bonitos had attached themselves to the Mackerel shoals, and had come to grief in the meshes of the nets; their more acutely angled heads and stouter bodies, with their greater weight, had no doubt caused them to fall out and sink to the bottom. I do not think any fisherman, who could hardly help noticing some slight difference in them from their commoner brethren, would throw overboard such distinguished-looking fishes. In size and appearance, excepting advanced decay, both heads were exactly akin.

There have been considerable numbers of the Scad (*Trachurus trachurus*), or Horse-Mackerel, of a size not exceeding the Herrings themselves, taken in the herring-nets during the months of October and November. Their presence has been

much remarked on by fish-buyers at the wharf, as the fishermen, who now "cran" out their takes instead of counting them, throw them into the baskets promiscuously with Whitings, small Mackerel, and the like, on the principle of all going to make up bulk.

The first Sprats sent up from Suffolk appeared on the fish-mongers' slabs on November 4th.

When strolling by the beach to the harbour-mouth on November 6th, I observed many dead and decaying Mackerel and Herrings which had been thrown up by the tide. Several Picked Dogfishes, averaging two feet in length, were also stranded, with some one-pound Whitings. All of these were undoubtedly fish that had fallen from the nets. I also found two Guillemots, which in all probability had also met with their demise in the meshes of the herring-nets. It has been observed that many of the Mackerel have been bitten this year by Dogfish.

Garfish plentiful with the Mackerel in October and November.

The Herring fishery up to the time of writing has been a sadly disappointing one; a succession of boisterous storms, following quickly on one another, has marred the prospects of fisher-folk, and those who follow them. Only once or twice has there seemed anything like a full wharf. Gales have come on so suddenly and unexpectedly after the nets have been "shot" at sea that it has been impossible to haul them, and much damage through entanglement and breakage has resulted. To my mind the catching power is now vastly too great (thanks to company-mongering and greed for dividends) for the necessarily restricted area to which the spawning shoals resort. I hope I am in error, but in my opinion there is a danger of scaring and breaking up the "schools," and that some day—and maybe it is not far distant—the harvest of the Herrings will not be so remunerative as of late years. There is no close-season; the grounds are worked every day in the week (save in very bad weather), Sundays included, and in my estimation the restless turmoil of a throbbing steam fleet crowding there must have a detrimental effect. These opinions may be speculative, but those who prophesied a few years ago that reckless, unscientific trawling would destroy the feeding-grounds of the deep-sea fishes this side the Dogger, although then laughed at, lived

to see the decay of once prosperous deep-sea ventures. A fleet of handsome trawlers still sail out of Lowestoft, but the same adjective may not be truthfully used when their gains are mentioned.

Up to the middle of November the huge number of buyers and others who follow the Herring fishery had great cause for grumbling. Fish were scarce, and realized big prices. Boat-owners had reason to mourn great losses of nets and precious nights; and those who labour ashore—fish-house hands, Scotch girls who gut the Herrings, and many others—had far too much idle time on their hands.

The Herrings would seem to have been "spotty," *i. e.* unevenly distributed. One boat, fishing off Cromer, for a night's work secured but three crans; a boat not far off made a catch of 150 crans. Big prices have been made, fresh Herrings often making 38s., overdays 35s., salted 32s., per cran. One boat brought in, on November 14th, 220 crans for three nights' fishing, making £300 of her catch. Up to November 15th the season's total was 28,340 lasts, as against 37,732 lasts for a corresponding period last year. A last of Herrings is 13,200; there are ten crans in a last. That the local authorities do not share my pessimistic forebodings is very evident by the Port and Haven Commissioners setting about to obtain powers to add to the existing accommodation by making a dock of about sixteen acres in extent, capable of finding room for some three hundred or four hundred more fishing-boats. The congestion in the harbour has led to a great outcry among the fishing fraternity. The number of local fishing-boats numbers, roughly, three hundred; from Scotch and other ports, six hundred.

With regard to the summer Mackerel fishery, I have not many details. Mr. Jay, assistant wharf-master, gives me the figures for 1910 (the season lasting from April to August) as follow:—Forty-five vessels, lasts 278 = 1,780,000 fish. This compares favourably with that of 1909, when forty-seven boats accounted for 256 lasts = 1,560,000 Mackerel. A considerable number of Mackerel have been taken during the autumnal Herring fishing.

Off Yarmouth, during the autumn, some tolerable catches of Codlings of four pounds each and upwards have on three or four occasions been taken in five or six fathoms of water, just beyond

the breakers, after spells of unsettled weather, by sea-anglers more plucky than those who kept to the piers, and who had to be content with occasional takes of small Whittings in shallower waters.

From Mr. T. G. Robson, piermaster, Claremont Pier, Lowestoft, I have received the following information, which, now that sea-angling has become a national pastime, is of some little interest :—"Owing to the prevalence of easterly winds in October and the beginning of November, sport has not been so good as usual, our best week's total being only 8652 fish, as follows : Whittings, 8047 ; Codling, 562 ; Dabs, &c., 43—this was during the week ending October 30th. During the corresponding week of last year, by rod and line, the number of Whittings taken was 16,288 ; Codlings, 149 ; Dabs, &c., 95."

Mr. Robson states the largest Codfish taken so far this season was one weighing $29\frac{1}{2}$ lb., caught from a boat; the largest taken from the pier weighing 16 lb. 2 oz. A Dab of 2 lb. 6 oz. was taken from a boat, and a Whiting from the pier 1 lb. 8 oz. One of the Lowestoft boatmen, fishing with a long line, secured in a single haul on November 4th twenty Cods, each over 20 lb., twenty over 15 lb., and twelve about 7 lb.

Mr. F. C. Cook, of Lowestoft, who is interested in the fishes of his neighbourhood, has provided me with the following items from notes made by him during the past year :—On February 22nd he observed the tail of a fish protruding from the mouth of a Thornback Ray, which, on pulling out, he discovered to be a Dab six inches in length. He noted that the Five-bearded Rockling was numerous taken in April by the shrimpers.

Heaps of Dogfishes (*Acanthias vulgaris*) were exposed for sale on the Lowestoft Wharf on May 27th, June 16th, and one or two other dates. Evidently there is a sale for them or the fishermen would not bring them in. Mackerel were observed to be much Dog-bitten in June. A Dogfish was noticed in the herring-dock eagerly pursuing "whitebait."

Flounders numerous in the basins in September ; among a large catch, to one rod, was a 2 lb. example. A 6 ft. Porbeagle Shark on September 20th. A Cod caught on a rod off Lowestoft late in October, weighing $29\frac{1}{2}$ lb. Some good catches of Sprats netted off South Lowestoft, second week in November.

To Mr. Robert Beazor, senr., fish-merchant, who spends most of his time on the fish-wharf, I am again indebted for some interesting notes. He writes:—

“Crabs and Lobsters: These begin to make their appearance on the wharf immediately after Christmas, and in barrels, forwarded by rail from Scotland; these contain from six to eight score. The supply this year was scarcer, frequent and continuous winds not admitting of the catchers going after them. The same causes often prevented the Cromer, Runton, and Sheringham catchers from going to overhaul or work their ‘pots’; the take of Norfolk Lobsters was in consequence a short one. During July and beginning of August these ‘fish’ go into the sand to re-shell, the Crabs somewhat earlier, when supplies are very short. This year has been notable for the rather large numbers of fine Lobsters landed by the trawling smacks fishing in the neighbourhood of Cromer ‘wold,’ many running from 3 lb. to 7 lb.

“Smelts: Smelting commenced early in the year. The first taken was in the third week in March, and continued up to the end of September. It was a very poor season owing to the prevalence of easterly winds and turbulent weather. The greatest number I had in one day was between four and five thousand. Big catches were the exception. Very few Sea-Trout and Grey Mullet were captured in the smelt-nets, and hardly any along the coast, owing to the same conditions.

“Mackerel have been abundant on the coast all the year; our midsummer ‘voyage’ was a record one for the numbers of fish landed. Sea-Trout in some years have come into my hands from the mackerel-nets in scores, averaging from $\frac{3}{4}$ lb. to $1\frac{1}{2}$ lb. each, but this year they were conspicuously absent, as were Red Mullet [Surmullet], only three of the latter having been taken to my personal knowledge.

“The midsummer Herring fishery was a complete failure, and so I think it likely to be so long as the Fishery Board permit spring Herring fishing. I consider there ought to be a close-time on this coast from Christmas to June.

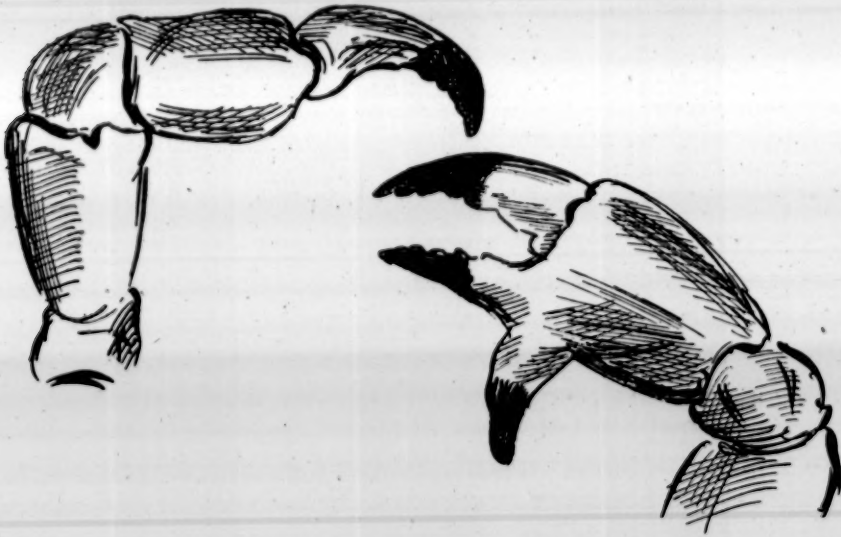
“Our autumn fishing up to the present has been backward owing to bad weather. Prices have been abnormally high. We have about one thousand vessels fishing from this port, over

six hundred of them Scotch and three hundred Yarmouth boats, now mostly steamers. The old sailing craft are becoming things of the past, owners having a great difficulty in securing crews to man them. Mackerel have been very freely taken with the Herrings, as have 'Horse-Mackerel,' which have been over-abundant.

"You ask me about Salmon caught at sea. I know of one of about 16 lb., being landed here in 1907 or 1908 by a steam trawler, that had been taken in the trawl-net, and another brought in by a steam drifter of 12½ lb. weight, which had rolled itself up in the herring-nets."

Among the more interesting crustaceans that have come to hand may be mentioned a Sowerby's Hippolyte (*Hippolyte spinus*), a small, sturdy species with an extraordinary development of the rostrum, which reminds one of a cock's comb; so conspicuous is the little fellow, and so rarely found by our shrimpers, that its appearance is almost always noted by them when it occurs.

In May I secured a large pincer-claw of an Edible Crab with but one chela, and this the free-moving one, which, having no



MALFORMED PINCER-CLAWS.

opposing point to close against, entirely precluded the possibility of this half nipper being of any use to its owner. On July 25th a large pincer-claw of the same species was handed to me

by a vendor of Crabs. It had an extra fixed chela protruding from the under side, at right angles to the under fixed chela (see fig.).

On August 14th I examined a Whelk with two opercula; the most extraordinary mollusc I ever saw, which, vulgarly speaking, was absolutely two-headed.

In August an undoubted occurrence of the Velvet Fiddler-Crab (*Portunus puber*) was noted by a shrimper, the specimen being saved for me by its captor until it became offensive. I was on my holidays at the time, hence it did not come into my hands. Fortunately another—a fine male example—was taken in a shrimp-net, and was brought home alive by the shrimper, from whom I received it next day. It had been placed in a bucket of water on a top shelf in his shop, but had died during the night, and its colours had much deteriorated. This is an interesting addition to the fauna of East Norfolk.

On December 3rd, owing to the unsettled state of the weather, almost all the Yarmouth boats were in port. Several crans of exceedingly fine Herrings which were landed from one of the boats realized the exceptional price of 49s. 6d. per cran, equivalent to 10s. per hundred! Most of the Scotch boats had gone home by this date.

THE COLOUR OF THE KINGFISHER.

BY FREDK. J. STUBBS.

JUDGING from the published remarks of British ornithologists, few people can be aware that the brilliant feathers on the back of the common Kingfisher vary from a deep ultramarine to pale straw colour, and that they alter strictly according to the conditions of light. Generally speaking, the bird is ultramarine when between the eye and the light; cobalt in the open air by almost every light, or in a room with good windows; green when the observer is between the bird and the source of light; and straw-yellow when the feathers are viewed at an extremely small angle, the observer being between the light and the bird.

There is considerable variation due to age and sex, and feathers from different parts of the body vary in intensity of colour, but they all behave exactly the same under similar conditions of light. The dorsal plumes nearest the tail are often the brightest and the bluest, but by arranging the bird in a suitable light they will be seen to change through green to a dull yellow—and, as I shall show presently, to a rich reddish brown.

Poets, presumably, draw their inspirations and ideas from birds seen in the field, and this explains why they are almost unanimous in speaking of the "sapphire blue" of the Halcyon. The artist in paint is not so lucky, for however well he may know the living Kingfisher, there is always a risk that he will fall into the error of making a careful study of a *green* Kingfisher in a dark case in some museum, and working this into the foreground of his picture. One frequently meets with instances of an indoor Kingfisher painted in an open-air picture; but, I remember, the bird appears in appropriate tints in a famous picture by Sir J. E. Millais. The descriptions published by ornithologists are one and all vague—at any rate, I have not read an exact description. Even Dr. R. B. Sharpe, who knew

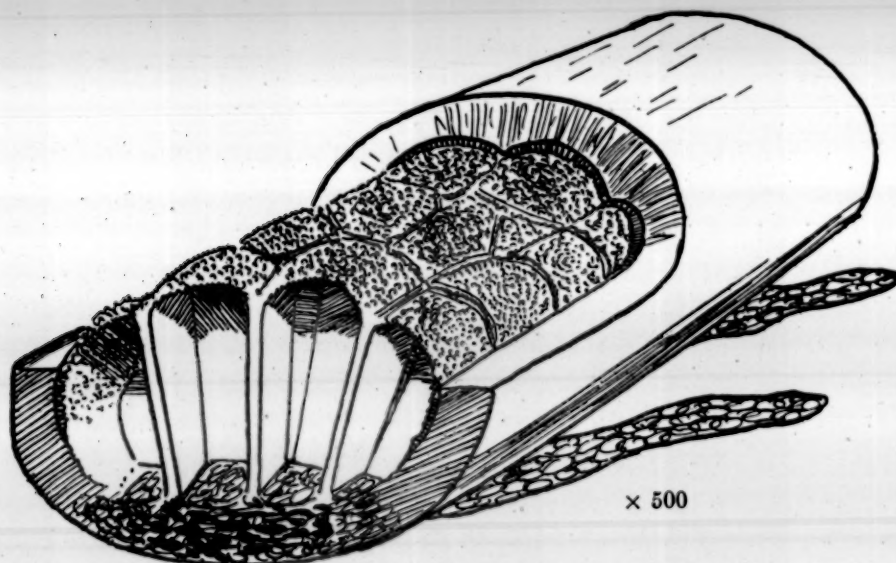
the Kingfishers very well, and William Macgillivray, who was the possessor of an extraordinarily sagacious eye, both describe the plumage of *Alcedo ispida* in a manner that is not precise.

What is the true colour of the Kingfisher? One is almost safe in saying it has none at all, for the blue parts of the feathers are colourless and transparent. Blue pigment has not been discovered in any bird, and green only in the small group of the *Musophagidæ*. Very few naturalists have investigated the nature of these unpigmented brilliant feathers. Professor Victor Fatio appears to have been the first, and his paper and plates (Mem. Soc. Phys. Hist. Nat., Genève, xviii. 1866) are very good. Yet he has one or two errors, and while describing the structure of the feathers (chiefly in the Indian Blue-bird, *Irena puella*), he offers no explanation of the cause of their blue colour. Some sixteen years later Dr. Hans Gadow examined the feathers of a number of birds, and described (P. Z. S. 1882) the blue ones of an Ant Thrush (*Pitta moluccensis* = *P. cyanoptera*). After noticing a series of ridges in the feathers of both *Pitta* and *Cæreba*, he suggested the theory of "Gitterfarben," or grating colours, to explain the blue of feathers. It may be stated at once that such ridges do not occur in the Kingfisher, although they are said to do so in other birds. Dr. Gadow was mistaken in saying that by transmitted light a blue feather is always the colour of its pigment; and there are one or two other points of error, such as stating that the colour is the combination of structure and pigment (which does not hold good for the Kingfisher), and in stating that the structural layer always overlies the pigment acting in combination with it (*cf.* also Newton's 'Dictionary of Birds,' p. 96).

Further consideration of the matter may therefore be advisable; but the difficulties attending the study of the minute structure of feathers are so many that I have had to confine my chief attention to the Kingfisher, and therefore I cannot speak definitely of many other birds. The following remarks apply, except where the contrary is expressly stated, to the blue feathers from the back of the common British Kingfisher.

I trust that the accompanying diagram will save me some verbal explanation. It figures, partly in section, a small portion of a single barb or ramus. The ventral or lower surface consists

of cellular *ceratin* or feather substance slightly pigmented with melanin. From this pigmented part arise the scanty barbules, which are also charged with melanin, although never appearing blue. Springing from the lower inner surface is a single stratum of polyhedral cells. Fatio, who was the first to describe this



important element of blue feathers, employed the word *émail*, and used the happy term *les plumes émailles* for all blue or green feathers; all who have examined the feathers of the Kingfisher under the microscope must have remarked their resemblance to fine enamel. Around and above these polyhedral cells there is a strong tubular and transparent sheath, which is, as the diagram shows, simply a prolongation of the sides of the pigmented lower part of the barb.

These cells are alone the source of the blue of the Kingfisher. With care, the pigmented portion of the barb may be cut entirely away, without any appreciable difference to the brilliancy of the feather. This clearly proves that pigment is not always an essential item of blue feathers. In the Kingfisher, as in every other bird that I have examined, the transparent outer sheath may also be removed without affecting the blue colour beneath; in the above bird the sheath is colourless, but in the green feathers of some Parrots it is clear yellow. Here, again, my experience has never agreed with Dr. Gadow's statement

that the yellow pigment in green feathers always underlies the structural layer. The inner surface of the sheath is often (perhaps invariably) marked out in hollows corresponding exactly in shape with the caps of the cells below. There is a strong probability that these serve as tiny lenses, and increase the brilliancy of the parts below.

A single example of the polyhedral cells may now be examined in detail. It is about one-thousandth of an inch in breadth, and rather more in height. Its inferior wall or floor is formed by the upper part of the pigmented base of the barb, and the vertical walls are perfectly smooth, transparent, and colourless. The cell is empty, and the coloured nucleus figured by Fatio does not exist in fact.

None of the feather elements so far considered have any part in the production of the blue colour. The pigmented parts of the barb, the transparent sheath, and the vertical cell-walls may all be removed without destroying the blue. This is only produced by the tops or caps of the polyhedral cells. In spite of the fact that these objects rarely exceed $\cdot 025$ mm. in length, it is comparatively easy to separate one of the caps, and to arrange it for examination under the high powers of a microscope.

Even by means of a good hand-lens this tiny plate of ceratin is seen to be brilliantly blue. Under the compound microscope, using the highest power possible with incident light, the surface is seen to be finely granular, without the slightest trace of the ridges seen by Dr. Gadow in *Pitta*. I am unable to see the shape of these grains or wrinkles, but in the aggregate they look like the roe of a fish. The largest of them are plainly less than the one-fifty-thousandth of an inch apart, for I have counted forty separate cells in the length of a millimetre of barb, and estimated far more than this number of grains across a single cell top.

This plate of ceratin is not flat, but slightly conical (or *patelloid*), especially in the centre of the barb. In manipulation the apex may be pushed down into the middle of the cell, and so be rather misleading. Under a proper light it is all over brilliantly blue, and the colour and structure are the same on both surfaces. This highly important fact can be seen by mounting a single cap very firmly between two thin cover-glasses and

examining from both sides. The blue is only seen by reflected or incident light; by transmitted light the cap is a rich orange-brown, with no trace of blue. It is figured as the cell nucleus by Fatio, and described as the pigment by Gadow. Collectively, the cell-caps give the rich brown colour we see when we look through a Kingfisher's feather (especially slightly diagonally) at a strong light. The following striking experiment proves this orange—and sometimes blue—cap to be neither a coloured nucleus nor a pigmented cell-wall.

When a single cap (or, better still, a connected series) is mounted dry and examined by incident light, the blue colour can only be described as a glare. If we allow a drop of a mixture of xylol and Canada balsam to flow down the slide, the very instant it reaches the cell-cap the brilliant light is snapped off as suddenly and as completely as in the switching off of an electric lamp; and the most delicate adjustment of the microscope fails to reveal any further trace of the fragment of feather. By transmitted light, by which the cap resembles a flake of orange shellac, the xylol and balsam act in causing an obliteration almost as complete. When the fluid reaches it, the rich orange vanishes instantaneously, and all that remains is a thin and only just visible plate of perfectly transparent ceratin. Sometimes the disappearance is complete, and the cap is not seen again; but previous treatment with some such substance as fuchsin enables it to be kept always in view.

This experiment paves the way for a solution of the problem of the blue colour in the Kingfisher and many other birds. It is clear that the colour is not due to pigment, either directly (as yellow is produced in a Canary) or indirectly, as Dr. Gadow has said. The absence of striæ—and above all the behaviour of the colour under different arrangements of the light—enables us to dismiss the suggestion of "Gitterfarben." Leaving out of account polarization colours, which are impossible in feathers, we have but three remaining explanations to consider. The first is prismatic colour. If the grains on the surfaces of the cell-caps are prisms, we should certainly see under the microscope at least the sparks of some other colour besides blue—the tiny gleams of yellowish white are from a known source that it is not necessary to explain here. The case of the *Eclectus*, presently

to be described, hardly agrees with a prismatic solution. Many animal colours, especially in molluscs and insects, are due to thin plates; and probably many metallic bird colours are formed in the same manner.*

The microscopical appearance of the surfaces of the cell-caps, their behaviour in various media, and the fact that no other colour but blue is produced, leads us to dismiss the question of thin plate or interference colours in the feathers of the Kingfisher; but the greatest objection is to be mentioned later.

We have thus disposed of every explanation except one, and that is the theory of the production of blue by the reflection of light from small particles, and of orange or red by the transmission of light *through* small particles. I suppose everybody has noticed the bright blue colour of the smoke from a wood fire when seen against a dark background of woodland or mountain; seen against the bright sky, the smoke is no longer blue but orange. It is the same with a mixture of milk and water, where the minute globules of fat reflect a blue colour but transmit orange—for the fluid is decidedly yellow when held to the light. The blue of the human eye is said to be due to the effect of light on the particles in the substance of the iris; and it is well known to physicists that blue may be produced by condensing various gases, or more simply by dropping an alcoholic solution of mastic into a vessel of pure water. Yet we get the phenomenon on the grandest scale almost daily in the blue of the sky. By reflected light the colour is pure blue, but as the sun sinks to the horizon we see the atmosphere by transmitted light, and it is then orange. This is hardly the place to describe matters that are treated at length in every elementary book on light, but a couple of lines or so may be given. In white light the red waves are twice as big as the blue. When light impinges on a collection of tiny points a great deal is reflected intact as white light, but many of the red waves get broken up into

* I know this is not the usually accepted explanation of the metallic tints of feathers. If we take a blue feather from the neck of a Peacock, and cautiously wipe it with a solution of caustic potash, with the effect of thinning the outer layers of ceratin, the range of green and blue tints gives way to one of bronze-browns and reds. I cannot see how this fits in with the *prismatic* explanation; and there are other serious objections.

smaller waves, and thus we get a light that is lacking in long red waves, and overburdened with short blue waves. By transmitted light the opposite effect is produced, and an excess of red comes through to the eye.

Every observation made on blue feathers supports this theory of the "colour of small particles." The disappearance of the light and colour in xylol and balsam is due to the fact that the fluid sets up optical continuity; and the cap becomes, so far as its individual effect on light is concerned, a part of the balsam. We cannot easily order the experiment, but it sometimes happens when dealing with fragments of feathers that the balsam reaches only a single surface of the cap (as when the cell is still intact, but the outer sheath of the barb removed); and in this case there is only a marked diminution of the colour, and not complete disappearance.

I now come to some of the strongest points in support of the theory. *Eclectus polychlorus*,* a wonderful Parrot found only in the Papuan Islands, shows a strange dissimilarity in the colours of the sexes. The male is almost entirely a brilliant and nearly optically pure green, with small areas of blue and scarlet. The female is largely bright red, diversified with very slight washes of blue and yellow. Roughly speaking, the male is all green and the female all red. Krukenberg has studied the actual pigments of the feathers of *Eclectus*, and shows that these are the same in both sexes, although the general effect is so different. The pigments number only three, and are *melanin* (black), *araroth* (red), and *zoofulvin* (yellow).

A feather from the back of the male is green. The barb consists of a solid core pigmented with black, a single layer of cells with bright blue caps—exactly the same as those in the Kingfisher—and an outer transparent sheath tinted with the yellow zoofulvin. Here again the colour does not agree with Dr. Gadow's statements, for the underlying melanin has nothing to do with either the blue or the green (as may easily be tested by slicing the barb with a sharp knife), and the zoofulvin, which turns the blue colour of the cell-caps into green, is obviously

* Perhaps this may be particularized as *E. roratus* for the male and *E. cardinalis* for the female, but my remarks doubtless hold good for the other forms of this Parrot.

above and not below the structural layer. Viewed from the inside, the barb of the green *Eclectus* is exactly the colour of that of the Kingfisher, i. e. a fine azure blue. Nor is this all, for the blue of the female is produced in the same way, and the purple is due to the barbules and part of the barb being tinted with araroth; here the red does not overlie the cells, but shows on each side of the layer. The above facts simplify the question of the colouring of the sexes in this interesting Parrot, but cannot be further discussed here.

In several other green and blue birds these granulated cell-caps are present. The common Amazon Parrot (*Chrysotis*) is an accessible example. I have examined thoroughly the feathers of but a small number of birds; but I may as well say that I have never examined a blue, green, or purple feather (I do not now refer to "metallic" feathers) without finding the colour to be produced by the granular tops of the special cells I have described, but always as blue, modified by red pigment in the purple feathers, and by yellow in the green ones. It must not be forgotten that many apparently blue feathers are really grey. For instance, the blue feathers on the wing of the Shoveller are black, with a fine line of white along the centre of each barb. This is the method of blue production in many birds, but such feathers are never "enamelled." In a similar manner, green is formed by a combination of zoöfulvin and melanin, as in the Green Woodpecker.

What do these facts suggest? I read it that the bird can only produce blue or blue compounds in this single manner. If blue is required, the protecting outer sheath is colourless; if green, it is tinted with yellow; and if purple, a line of blue modifies the colour of a feather pigmented with red. Dark blue, as in the tail of the Kingfisher, or in the feathers of many other birds, is caused by narrow lines of blue-producing cells with wide and black interspaces. I need hardly say that were the colours due to prisms, or to thin plates, the overlying pigment would be unnecessary. Yet, as we see, the base of these colours is always the sky-blue reflected from the caps of elaborately fashioned cells.

Perhaps I may summarize, then, that the blue colour of the Kingfisher is not due to pigments; nor, as Dr. Gadow suggests,

to striæ acting as diffraction gratings—which would, of course, only display colour in fixed directions of light; nor is the colour due to tiny prisms, nor to thin plates. I trust that I have succeeded in showing that it is due entirely to the effect of light reflected from a vast number of tiny projections on the surface of the wall of a special cell, and is quite independent of any pigment.

All that remains now is to return to the first question of the varying colours of the plumage of the Kingfisher. When we see *only* reflected light, the feathers are pure blue; but when a large part of the light is reflected from the back of the barb, and of course transmitted through the cap of the cell as orange, this colour turns the blue into a dusky green, and in certain aspects it may even be the only light striking the eye, so that the feathers appear straw-coloured. It frequently happens that a Kingfisher is more brilliant by artificial light than it is by daylight—a curious state of affairs. The explanation is very simple. The light is so weak that only a small proportion is sent back through the cell-caps as orange light, and so we get the blue colour unmixed and brilliant. In brilliant old male birds very little transmitted light penetrates the caps, and so the blue is purer than it is in immature or female Kingfishers.

NOTES AND QUERIES.

MAMMALIA.

A Local Race of Light-coloured Mice.—Mr. Gordon Dalglish (*ante*, p. 434), in writing of *Mus flavicollis* and other mice, says:—"I have in my possession a *M. musculus* mouse, which I took in a farm-building, so remarkable in colour—a bright yellowish fawn—that had it been taken abroad would certainly have led to a suspicion of its being a new species." An almost similar experience befell me last year. I had heard of a peculiar light-coloured race of mice that inhabited a solitary farm at the head of an isolated valley (The Washburn) lying between vast expanses of high moors, and far away from contact with other human habitations. Through the medium of a friend I obtained a specimen in May, 1909, but far too "gamey" for any hope of preserving it. It was a female—adult, but slightly undersized—and of a fawn or sandy colour throughout. Coming from a virgin district, the specimen was interesting to me, and suggested possibilities; but I had my suspicions, and I instituted an inquiry through my friend to ascertain if any tame white or parti-coloured mice had ever been kept at this farm. Later my friend replied:—"You have, I think, diagnosed the case exactly. . . . I found that at one time one of the family used to keep 'white' mice." Whether these light-coloured mice are the direct descendants of the "tame" mice, or whether these latter have interbred with wild *Mus musculus*, it would be difficult to say now. But that they appear to have succeeded in producing a local race of fawn-coloured mice is, I think, worthy of record. An analogous case amongst rabbits is developing at present on some of the islands of the Farne group, *viz.* on "The Brownsman" and on "The Farne." The bird-watchers there have liberated some of the Belgian "hare" breed of rabbits, which are interbreeding with the ordinary British wild rabbit, itself formerly introduced into these islands, I am told. The result is that the greater proportion of the rabbits there to-day are of a distinct type—fawn-coloured, but of a lighter shade underneath.—H. B. BOOTH (Ben Rhydding, Yorks).

AVES.

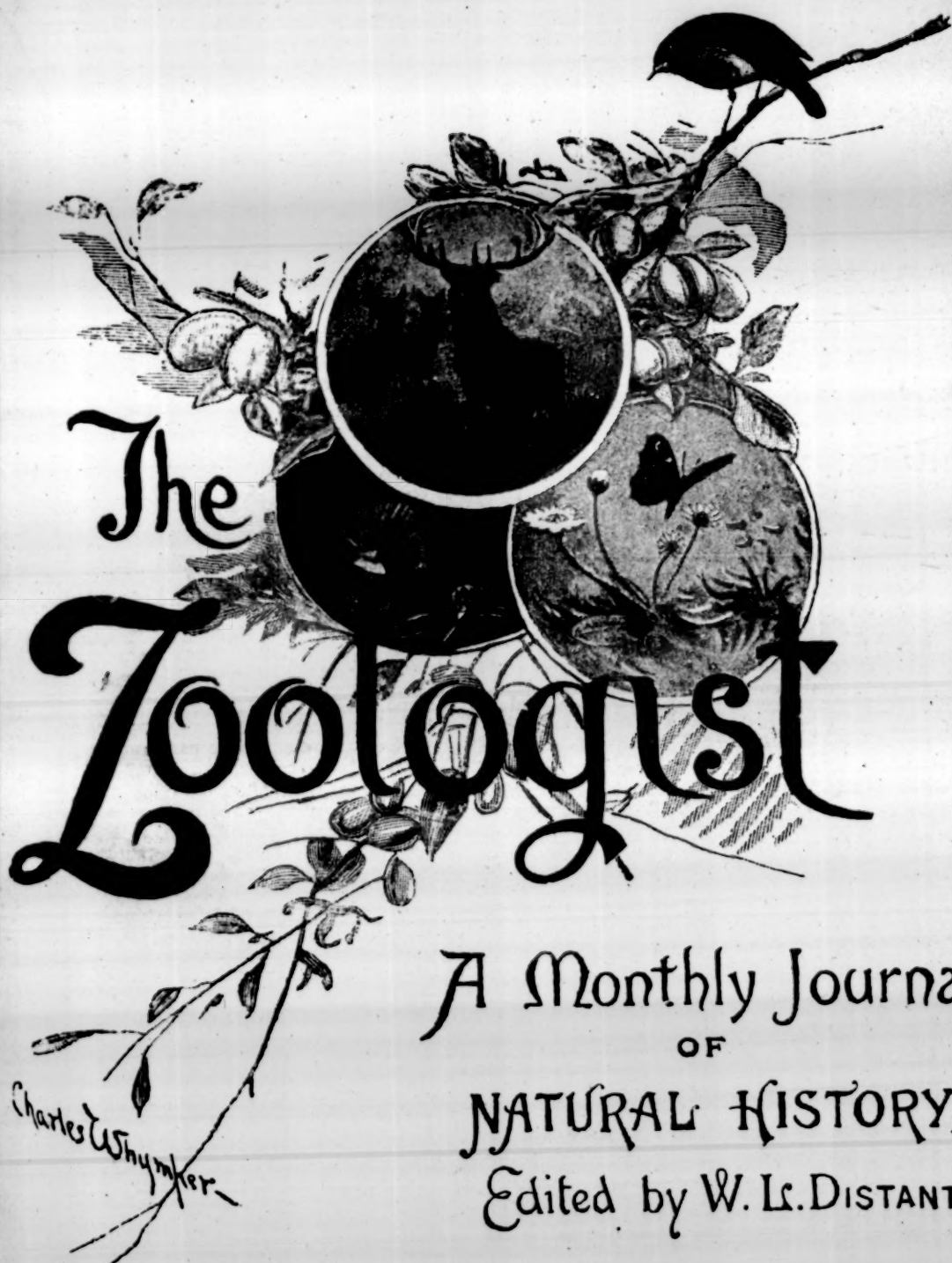
An Albino Bunting.—The word "Bunting" must be understood here in a generic sense, for the bird in question was so perfect an albino that I am unable to say whether it was, or rather is (for no one wishes to shoot it), a Yellowhammer or a Reed-Bunting. A Corn-Bunting it certainly is not. The movement of the tail proved it to be a Bunting, and a careful examination with a binocular when

it was busy with the seeds of the willow-herb suggested to me that it is probably a Yellowhammer. It has been haunting willows and sedges by the side of the railway like a Reed-Bunting, but there were Yellowhammers as well as Reed-Buntings about the same place. I could not catch any note that might have helped to decide the species. There is not a coloured feather in it, and it is, on a sunny morning, a most beautiful object. An albino Bunting of any species is, I imagine, a rarity.—W. WARDE FOWLER (Kingham, Chipping Norton).

Crossbill nesting in Bedfordshire.—On May 6th a friend and myself found in one of the pine woods at Sutton what was evidently the nest of the Crossbill; it had by some means become dislodged, and was lying upon the ground under the trees. Several Crossbills were seen at the time, and two males in full song were heard in this plantation previously. On May 8th, in a Scotch fir-plantation known as "Caesar's Camp," at Sandy, we saw a pair with young; the latter had recently left the nest, and we watched the old birds return to feed them from time to time. My attention was first directed to this family party by the variation in the notes of the birds.—J. STEELE ELLIOTT (Dowles Manor, Salop).

A Variety of the Gannet (*Sula bassana*).—The variety of the Gannet described by Mr. R. Fortune (*ante*, p. 340) is, I imagine, the first variety of this species ever recorded; moreover, it is doubly interesting, because it belongs to a very different class from the albinisms and melanisms which are from time to time reported among all birds. There is also an account of it in 'British Birds' (iv. p. 153), with a very good photograph by Mr. Jasper Atkinson, done from the bird as it sits on a rock beside two of the normal colour, with one of which it was believed to have paired. This is a *lusus nature* which is hardly explicable by the ordinary laws of variation in plumage; to account for it we may perhaps suppose an abnormal intensifying of the buff head and occiput, which is worn by the Gannet in its adult livery. If that be the solution, the buff pigment has not only spread over the entire head and neck and part of the wings, but has turned to a darker colour. There is another and, I think, more probable explanation of this strange freak. It may be a last year's bird still retaining some of its immature plumage, though now faded and altered so much as to be unrecognisable. But against this theory it is to be remembered that a young Gannet's plumage is black, not brown, and another point is that the dark plumage is always lost on the head and neck first, the lower back and tail being the last part to change.—J. H. GURNEY (Keswick Hall, Norwich).





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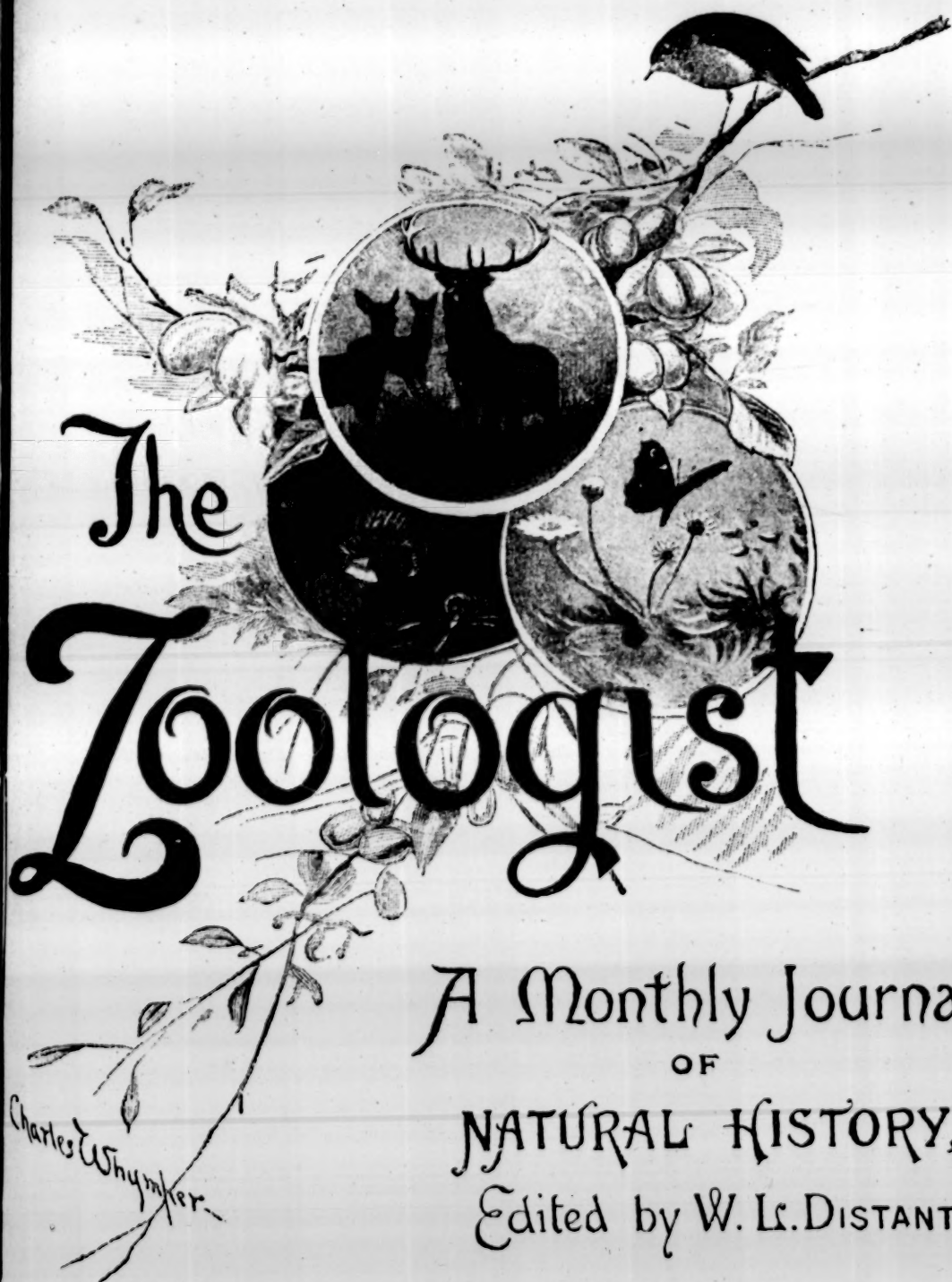
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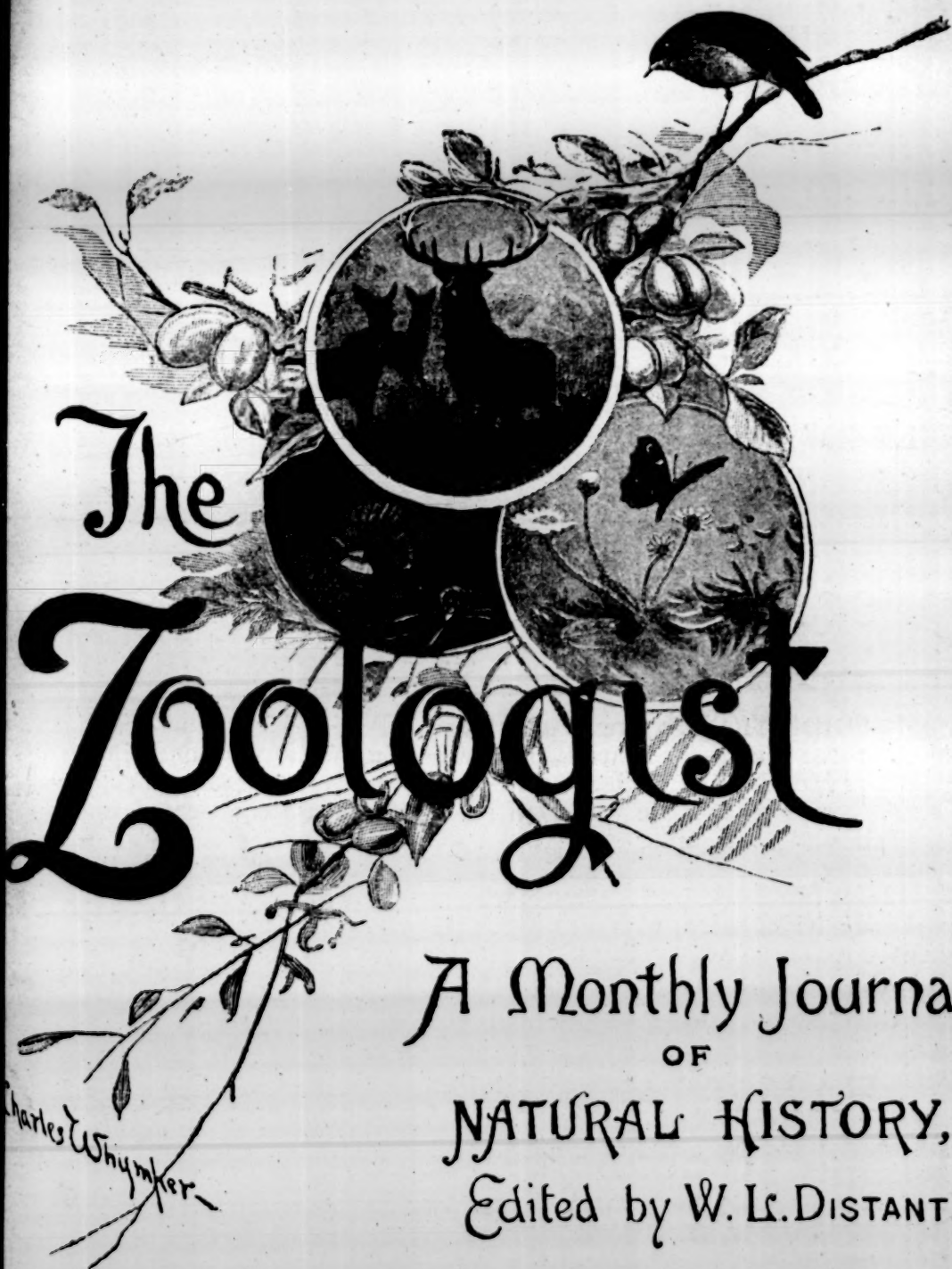
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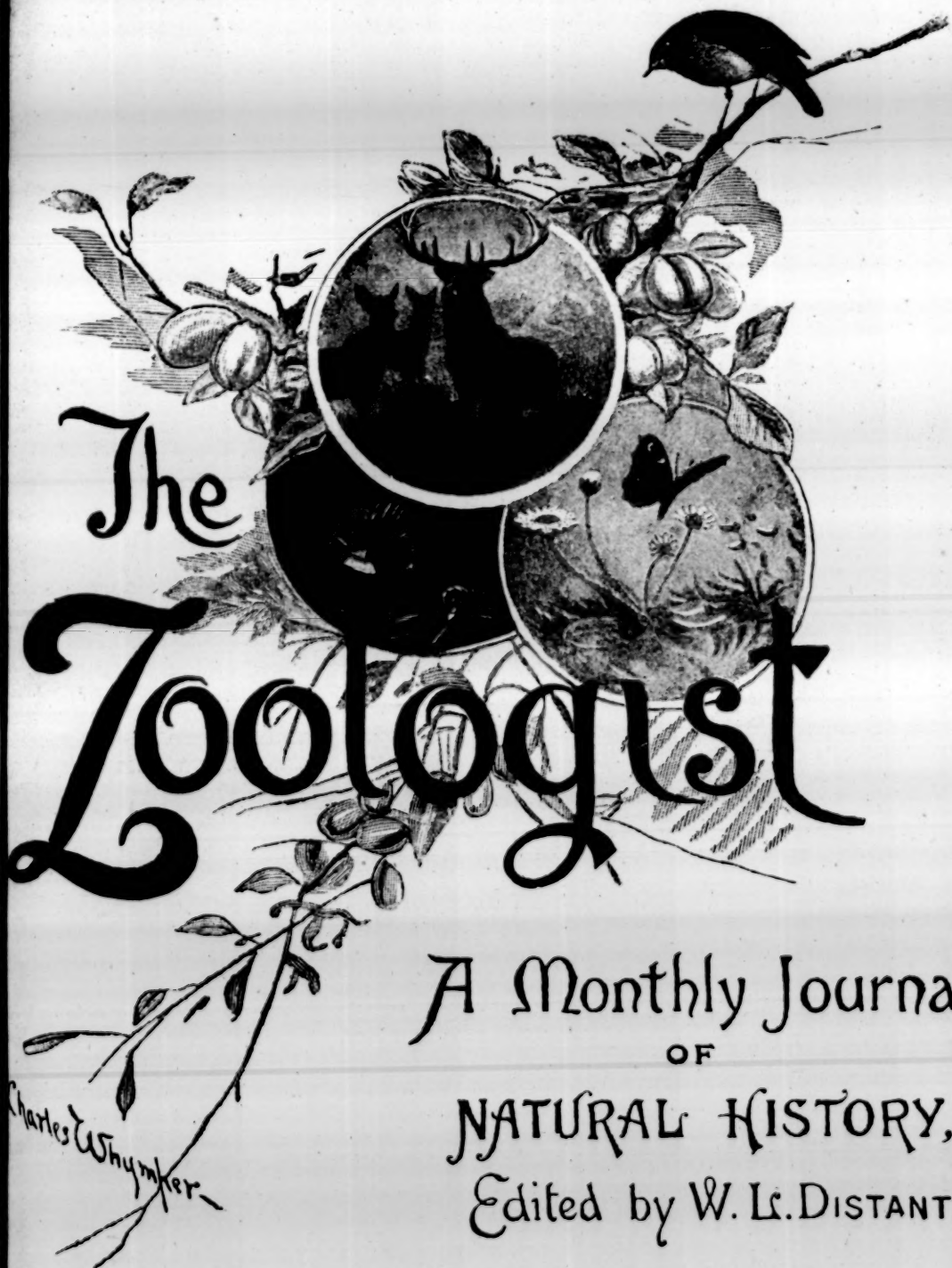
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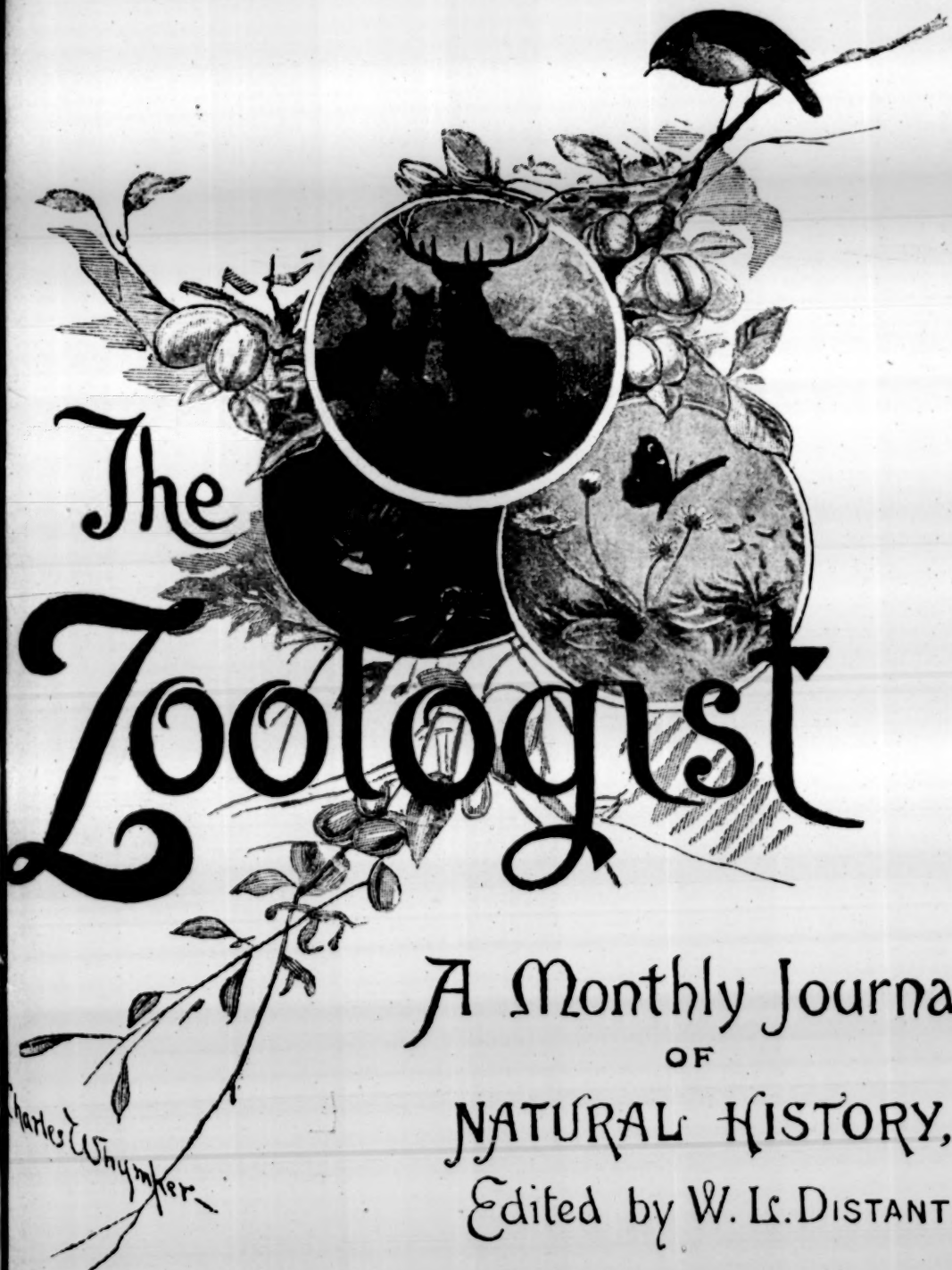
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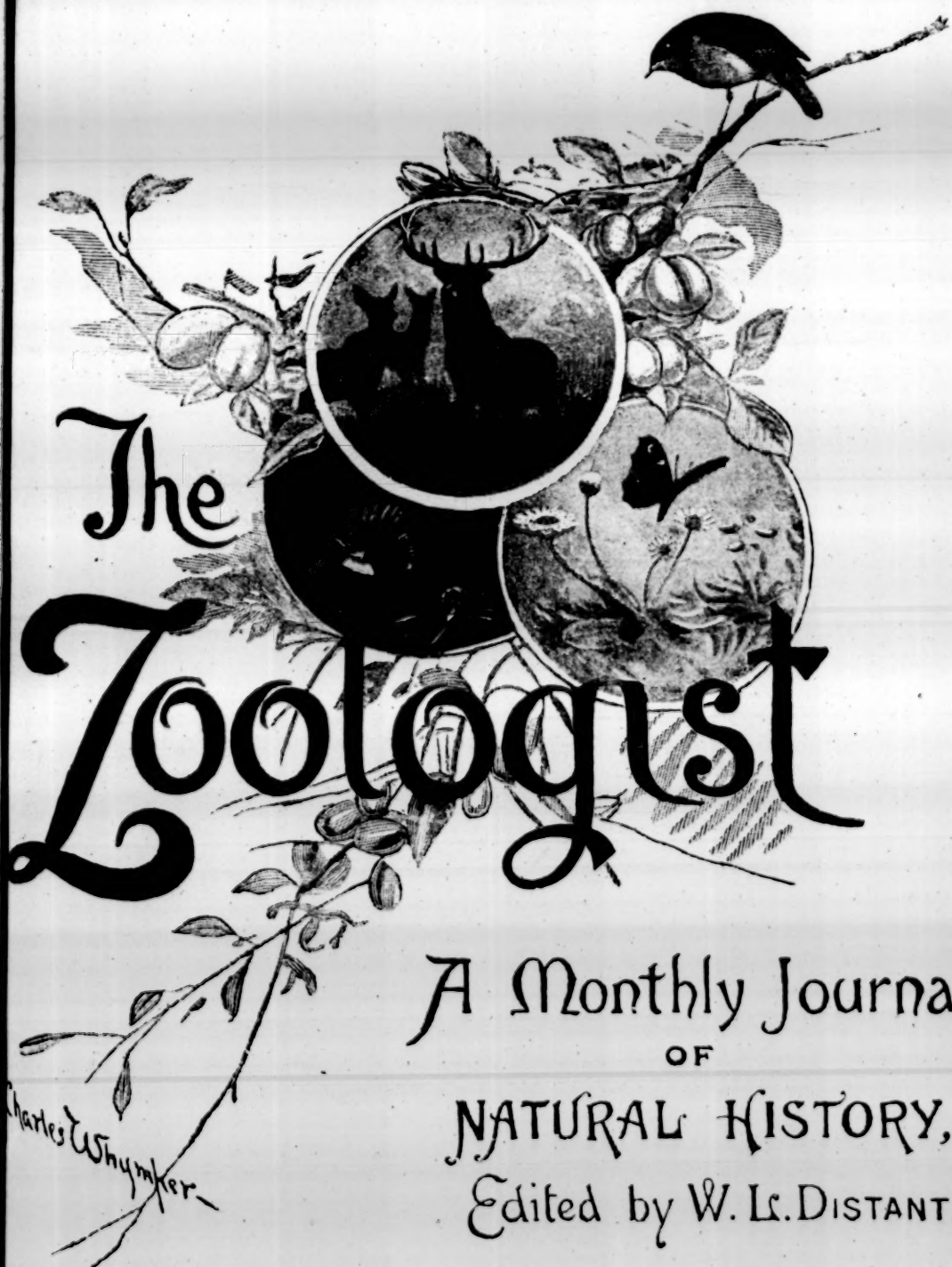
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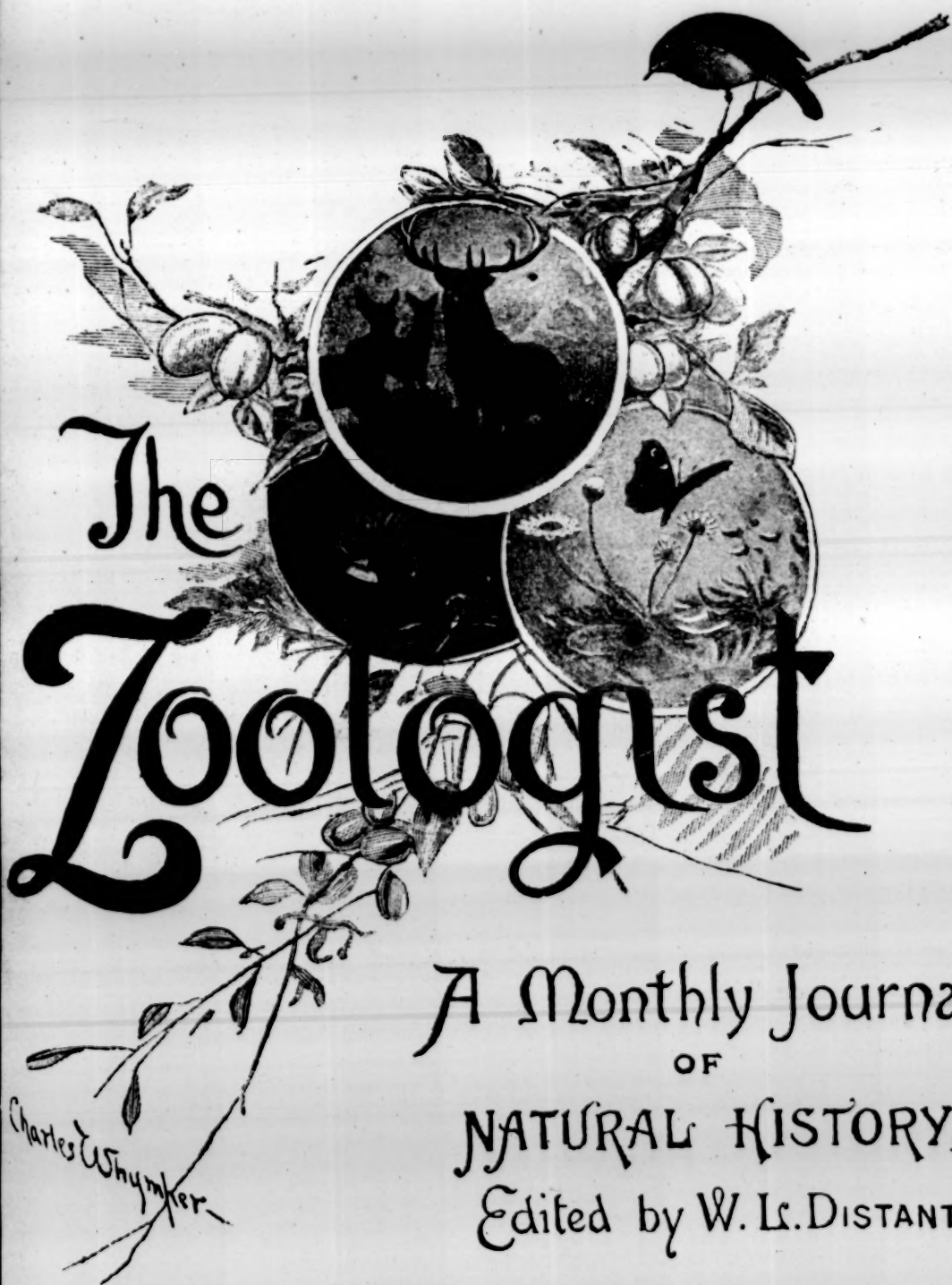
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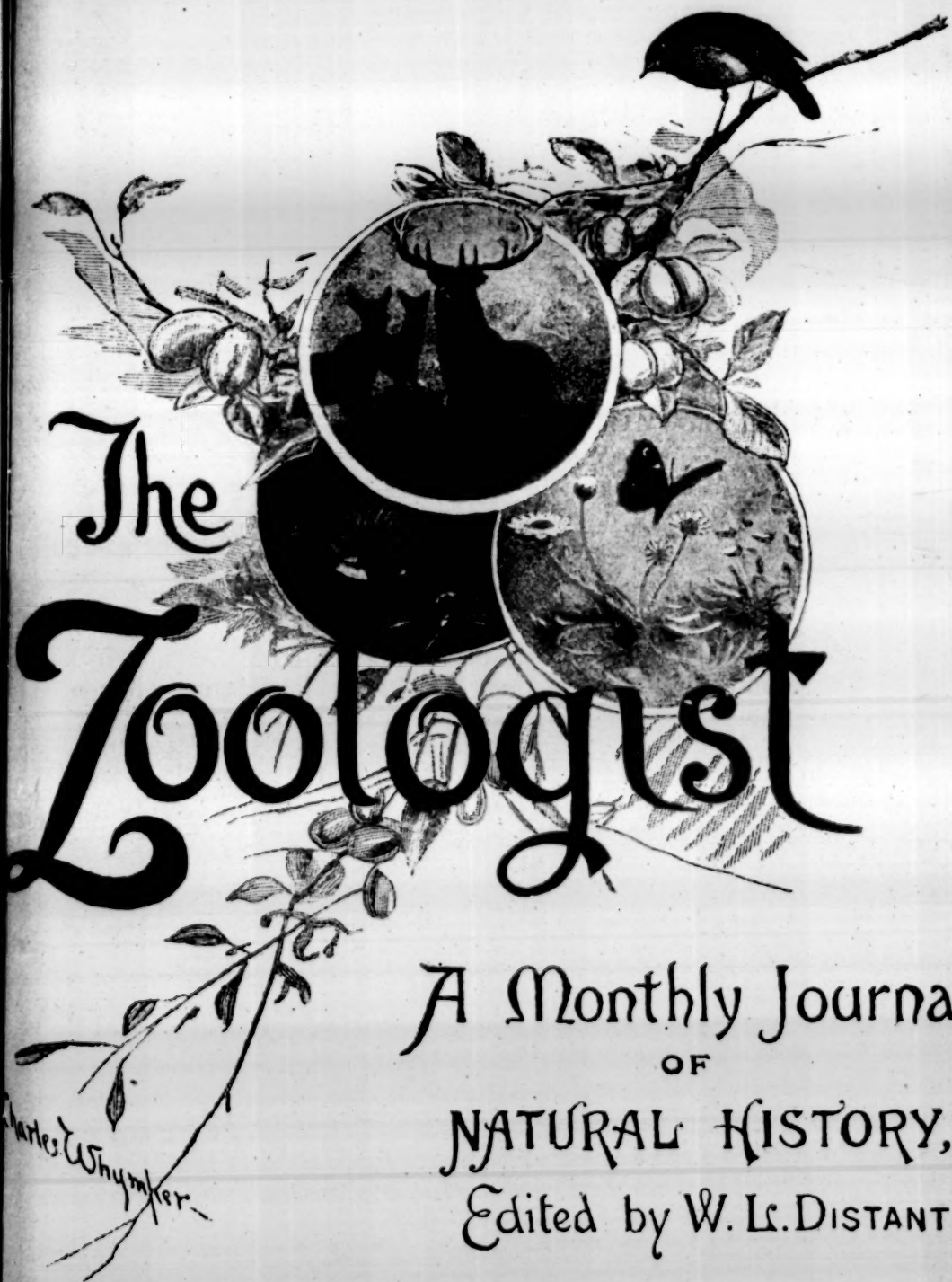
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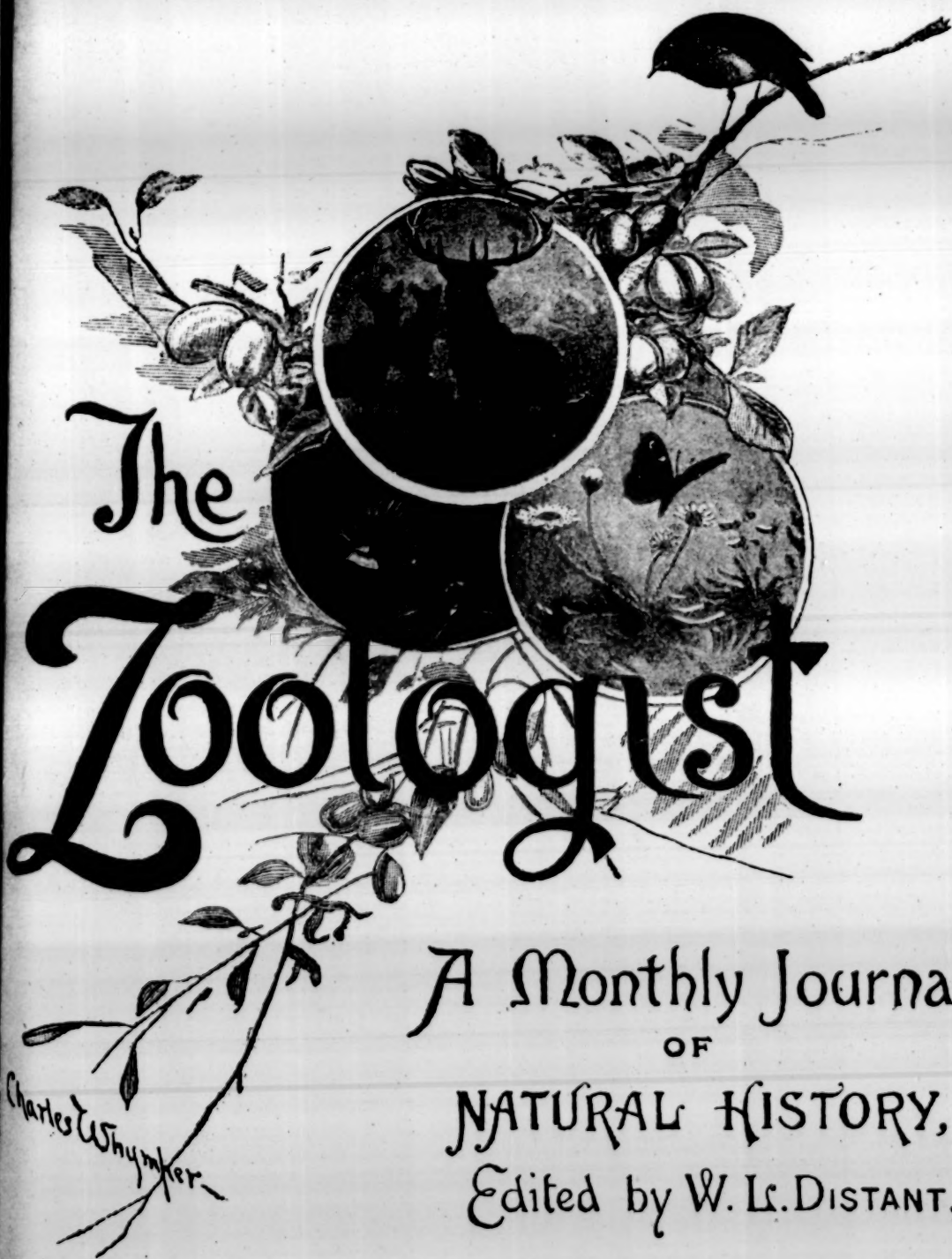
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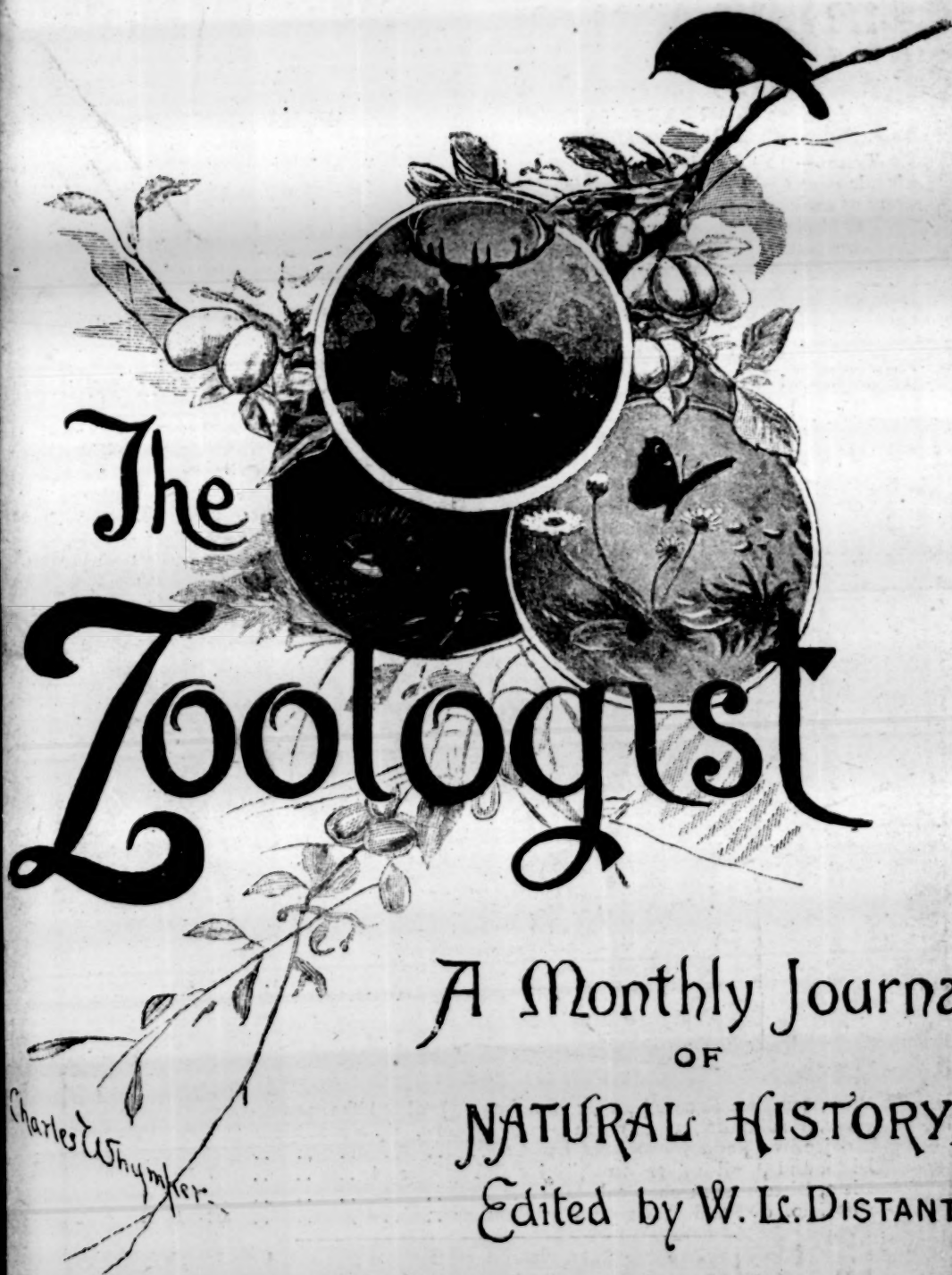
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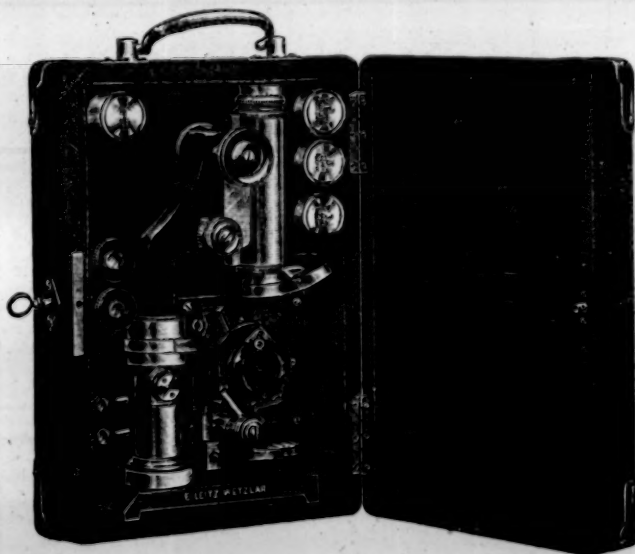
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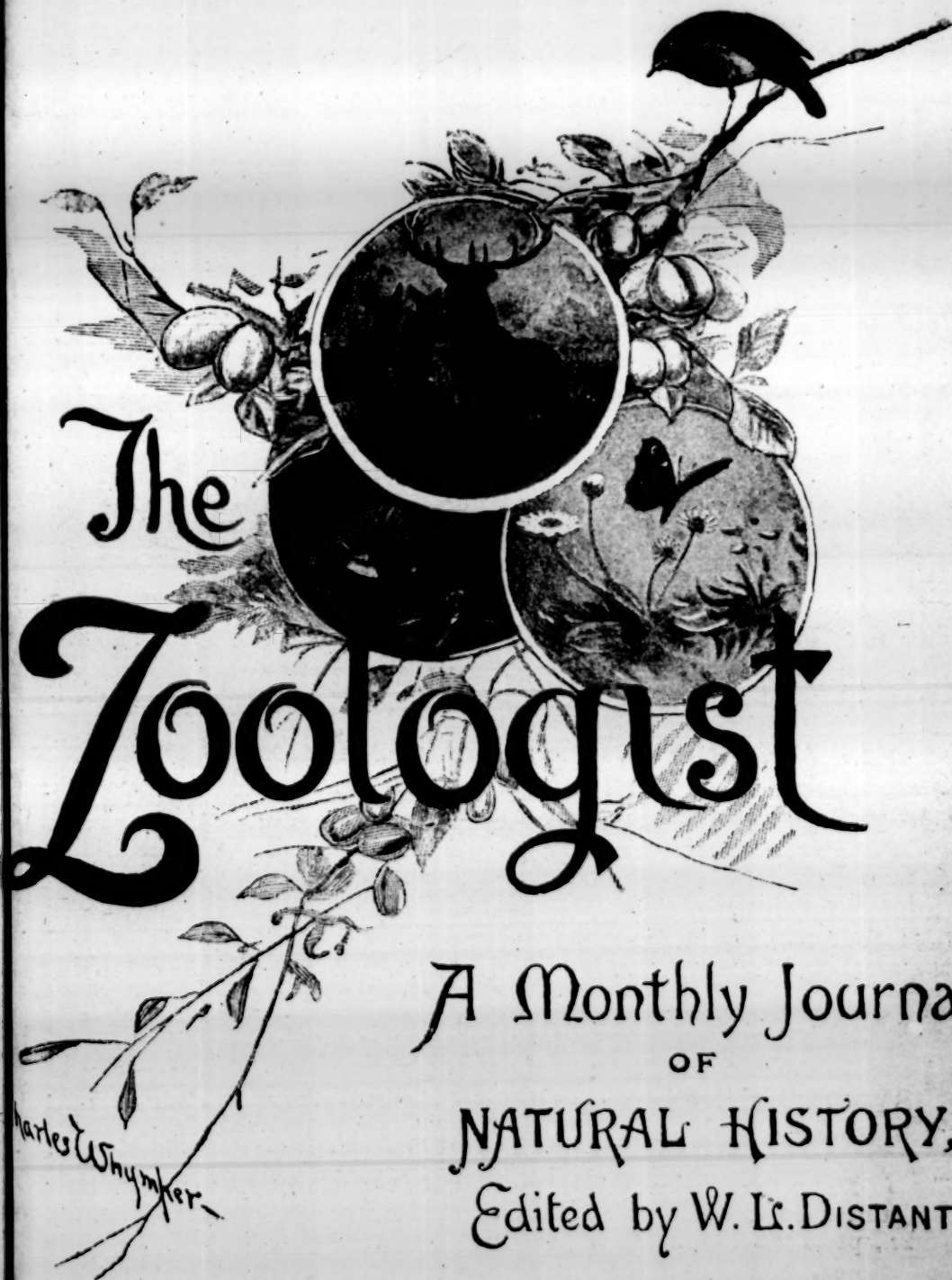
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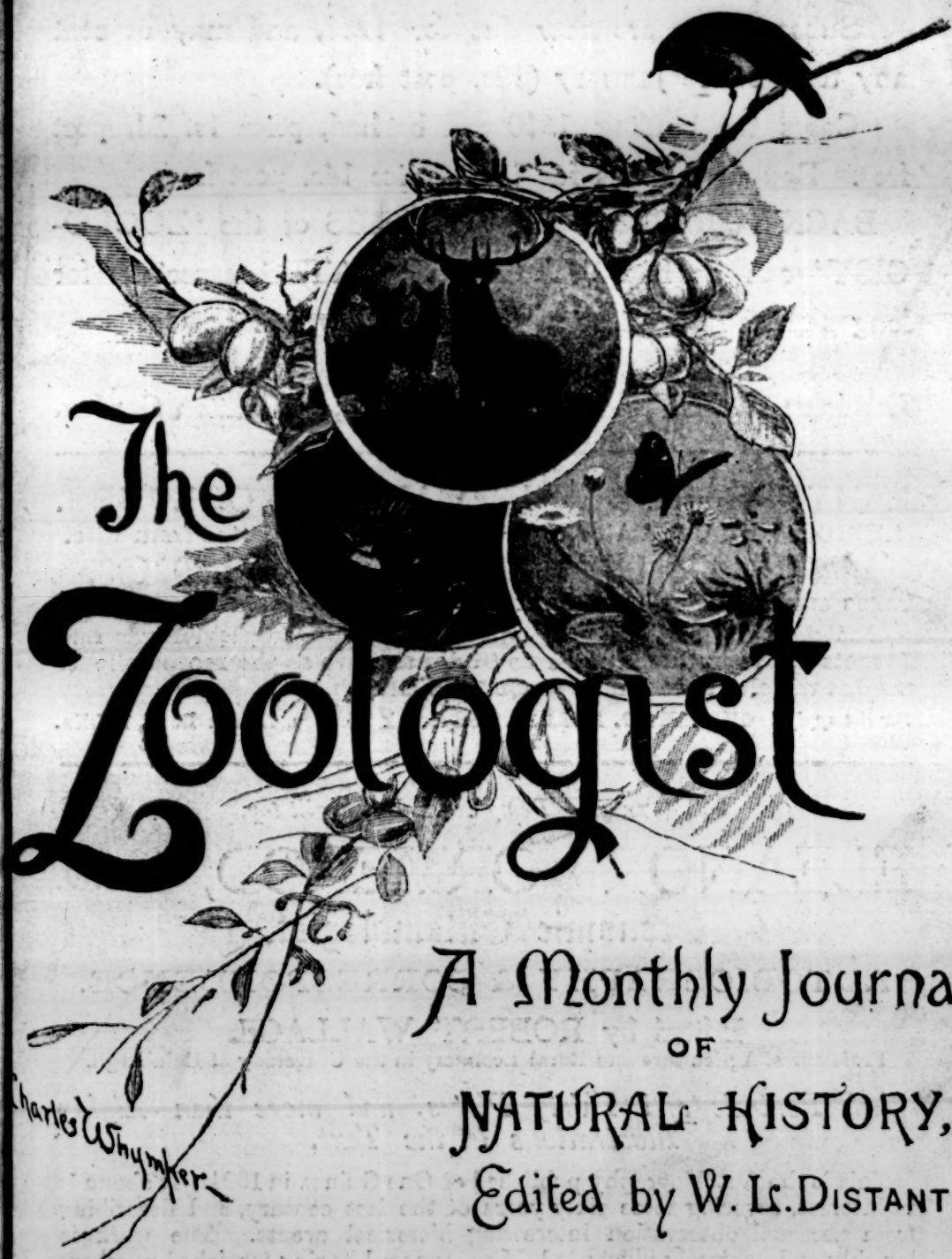
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